(12) UK Patent Application (19) GB (11) 2 099 710 A

(21) Application No 8216469
(22) Date of filing 7 Jun 1982
(30) Priority data
(31) 3122682
3122681
(32) 6 Jun 1981
6 Jun 1981
(33) Fed. Rep. of Germany (DE)
(43) Application published
15 Dec 1982
(51) INT CL³
A61M 11/00
(52) Domestic classification
A5T BB DF
B2F 120 325 343 344 346
JG
(56) Documents cited
None
(58) Field of search
A5T
(71) Applicants
Rowenta-Werke GmbH,
202—256 Waldstrasse,
6050 Offenbach am Main,
Federal Republic of
Germany
(72) Inventors
Clans Kühne,
Rainer Conrad
(74) Agents
Frank B. Dehn and Co.,
Imperial House, 15/19
Kingsway, London
WC2B 6UZ

(54) **Inhalant supply device for an ultrasonic inhaler**

(57) An ultrasonic inhaler has a breathing mask with ultrasonic head 4 driven by transducer 3 to evaporate pharmaceutical liquid delivered to the head from collapsible container and via conduit 2. The container 1 is forcibly collapsed by a pressure plate 8 fixed to the end of a plunger 13 which is received in hollow shaft 11. Rotation of the shaft by motor 6 through gears 7 causes the threaded plunger to rise by coaction with a thread formed in housing part 16 connected to a pivotable cover 18 arranged to close the cot container chamber 5 and to be locked by lock 19. Conduit 2 may be enclosed along part of its length with a heated block which serves to heat the inhalant before being atomised.

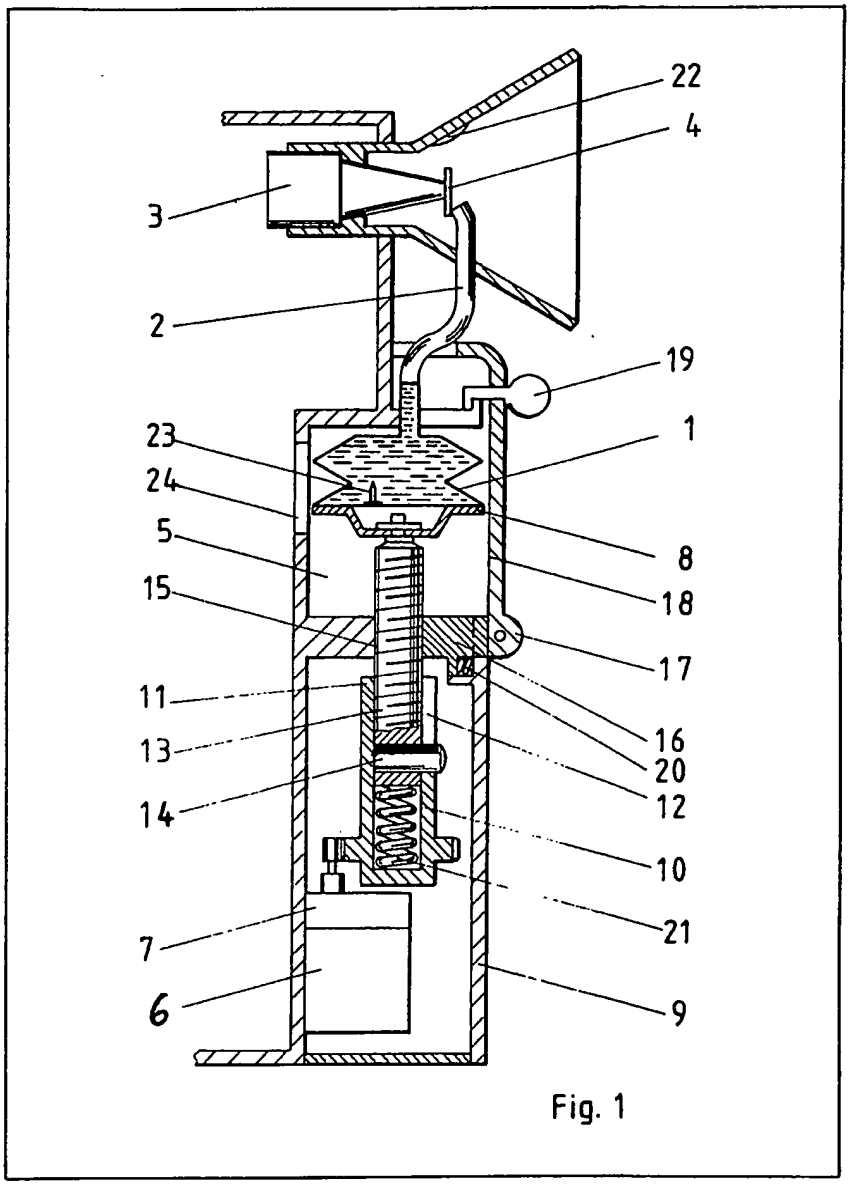

Fig. 1

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

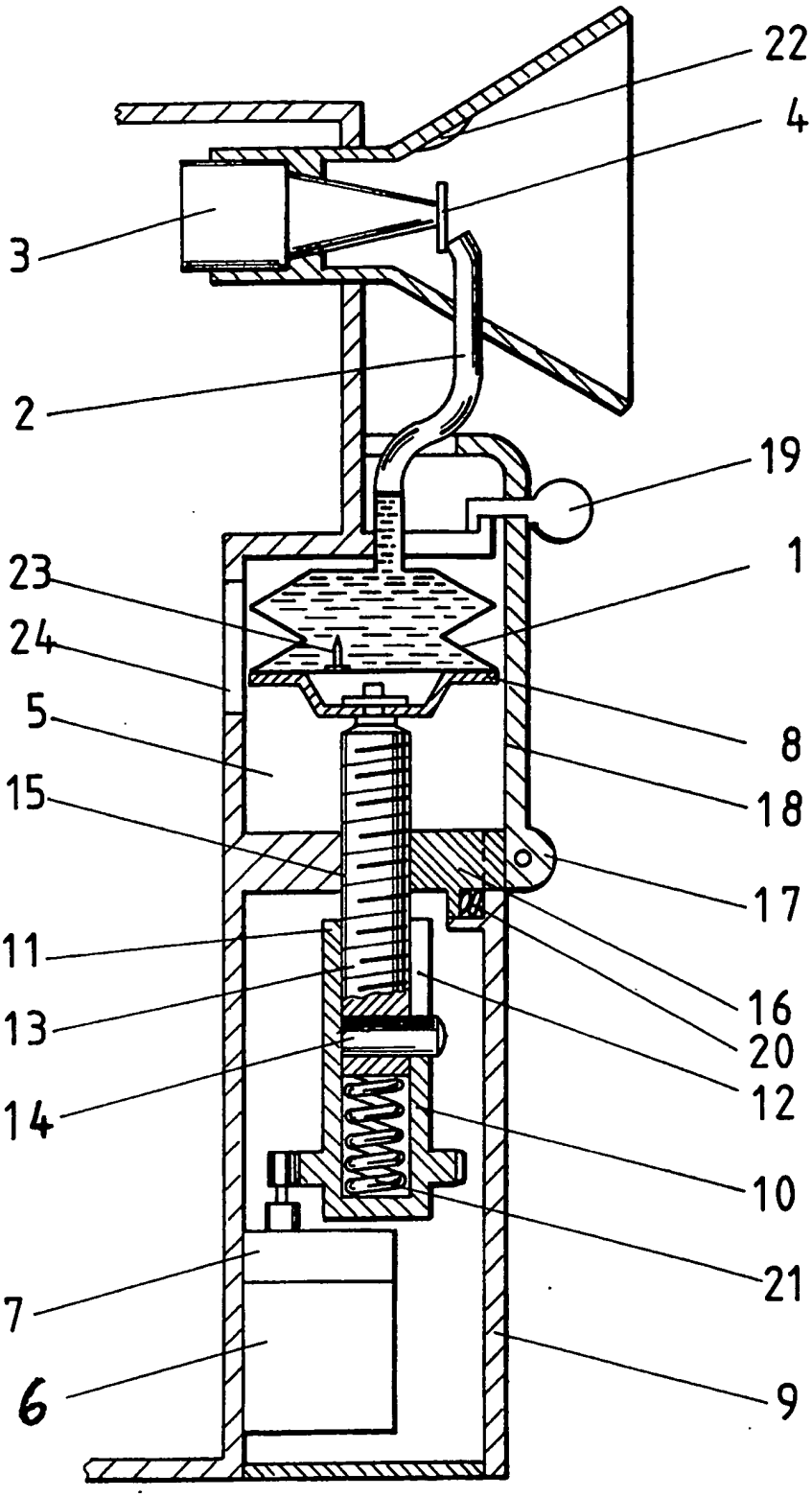

Fig. 1

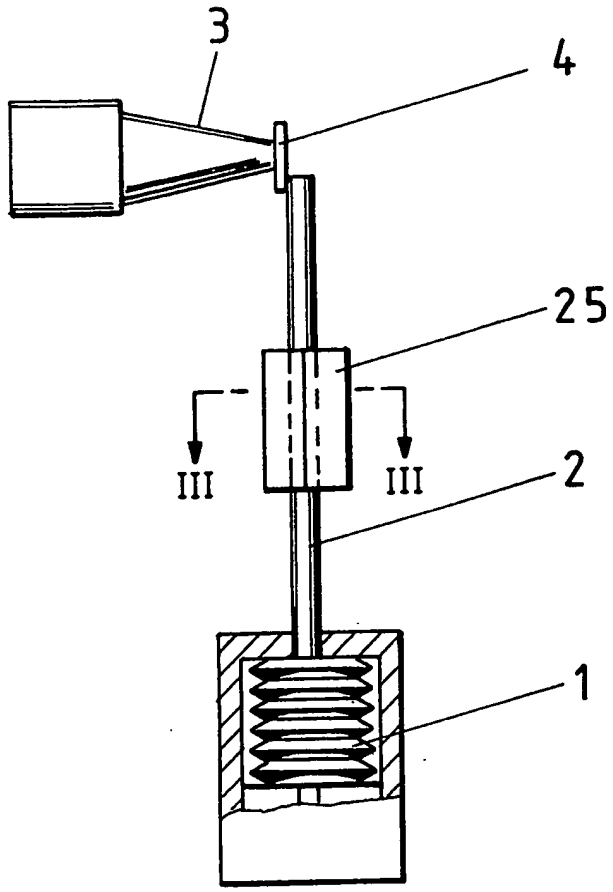

Fig. 2

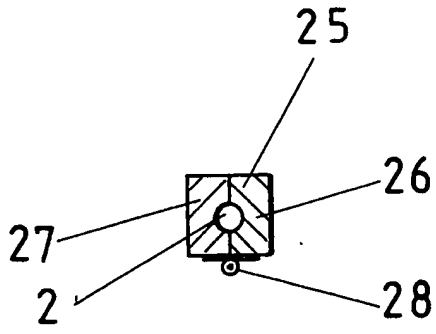

Fig. 3

SPECIFICATION

Inhalant supply device for an ultrasonic inhaler

The invention relates to an ultrasonic inhaler with a replaceable inhalant container, means for passing liquid to the resonator head and drive means.

Inhalers for treating the respiratory tract and the pharyngeal cavity are already known, wherein the inhalant is vaporised on resonator heads excited by ultrasound. Resonator heads of this kind are also known as "ultrasonic atomisers". The mist with a constant droplet size produced by the atomising of the inhalant acts on the mucus membranes when inhaled into the nasopharynx or on the surfaces of the blood vessels in the lungs, when inhaled more deeply into the respiratory tract, depending on the diameter of the droplets. It is known to provide the inhalers with a replaceable supply container for the inhalant so that previously metered doses of active ingredient can be administered (DE—OS 28 35 135). This prevents overdoses by the use of inhalants with toxic properties. In this known apparatus, the inhalant is conveyed to the atomiser element by the capillary effect. A uniform flow of inhalant to the atomiser cannot be guaranteed, owing to the different compositions of the inhalants and the different viscosities of the various inhalants (oils, emulsions, aqueous solutions, etc.). However, a uniform flow is not absolutely essential in order to obtain excellent therapeutic results. Moreover, the conveying action and the inhalant mist in this known apparatus are not interrupted during the breathing-out phase, which means that some expensive and very valuable inhalants are wasted.

The aim of this invention is to avoid the disadvantages of the known inhalers and to provide an ultrasonic inhaler for different applications, wherein accurately predetermined quantities of inhalant can be uniformly supplied to the resonator head per unit of time, irrespective of the nature or composition of the inhalant.

According to the invention there is provided an ultrasonic inhaler adapted for use with a replaceable inhalant container comprising a housing having a chamber adapted to receive a said container means being provided for conveying liquid expressed from the container to a resonator head, said housing further including means for forcibly collapsing said container said collapsing means comprising an electric motor adapted to rotate a hollow shaft having a longitudinal slot a threaded plunger being coaxially disposed within said shaft and having a laterally projecting pin guidably received in said slot, said plunger threadedly cooperating with a thread formed in the housing such that on rotation of said shaft the plunger is forwardly urged, said plunger having at its forward end a pressure plate adapted to forcibly deform said container to express fluid therefrom to said head, said housing thread being formed in part of a hinged cover for said chamber.

This ensures that the same quantity of inhalant is always supplied to the resonator head plate, in spite of the different compositions of the inhalants. A particular advantage here is that the inhalant can be packaged and supplied by the manufacturer in specific, i.e. metered quantities. The possibility of accidental or unintentional overdoses, e.g. of toxic medicaments, is ruled out. During the breathing-out phase, the conveying of inhalant may be interrupted by a switch. The changing of the pre-packed container of medicament can be effected very advantageously. When the container chamber closure is opened, a two-part bearing may open and the plunger in the form of a threaded spindle may move abruptly back to its original position. In this position, the empty container can be replaced by a full one, thus making the inhalation apparatus immediately ready for use again. After a new container of inhalant has been inserted, a compression spring mounted below the plunger pushes the plate of the against the base of the inhalant container. This does away with long idling times. Immediately the electric drive for the conveying means has been switched on, the pressure of the plunger on the base of the inhalant container comes into effect and the inhalant itself is passed through the tube of the inhalant container to the resonator head. According to a preferred feature of the invention, the switch for the conveying means may also be constructed as a diaphragm switch which reacts to the suction caused by breathing in and instigates the inhalant-conveying operation at the start of each breath. While the user is breathing out and in the pulses between breaths, no suction is created in the apparatus, the diaphragm switch responds and the conveying of inhalant to the atomiser is stopped. A pin projecting into the conveying chamber itself, at the pressure end of the conveying chamber closure, damages the wall of the inhalant container after the deformable inhalant container has been emptied. This makes it impossible for the container to be filled with other substances by a layman and re-used for improper treatment with inhalant. Finally, the provision of an inspection window in the housing makes it possible for the user to tell how much of the inhalant has already been used and how long the treatment with inhalant must be continued in order to empty the container completely.

In some cases, it may be extremely disadvantageous for the vaporised inhalants to come into contact with the respiratory organs which are to be treated whilst these inhalants are still cold. This may lead to irritation and in some cases may reduce or even entirely cancel out the therapeutic effect of the inhalant.

The aim of another aspect of the invention is to provide an ultrasonic inhaler wherein the inhalant is heated to the optimum treatment temperature for the inhalant before being atomised on the resonator head.

According to this aspect of the invention this problem is solved by the fact that the liquid carrying conduit is located in a block and the block is electrically heated. The block may consist of a

PTC material.

According to a further feature of the invention, the block is in two parts. The parts of the block are hinged to each other and the conduit or transporting means are located between the parts of the block. According to the invention, the transporting means may take the form of an elastically deformable tube and the tube is heat-resistant at +90°C. However, it is also possible for the transporting means to consist to a hollow needle.

In this way, it is ensured that the inhalant is heated to the desired temperature on its way from the inhalant container to the resonator plate. The inhalant no longer arrives on the atomiser plate while cold, but is heated to the optimum therapeutic temperature. It is particularly advantageous if the block is made from a PTC material since the choice of a resistant material eliminates the possibility of overheating on the block and hence of the inhalant and there is no need for any temperature restrictors. The fact that the block is divided into two parts means that the liquid transporting means can easily be inserted in the block. Moreover, this enables the block parts hinged together to be changed or replaced. Depending on the desired temperature of the inhalant, it is possible to use a block part made from PTC material with a higher transition temperature or a lower transition temperature. The use of an elastically deformable transporting means which is heat-resistant up to +90°C prevents the inhalant from overheating before it is atomised on the atomiser plate of the ultrasonic head. The use of a hollow needle as the transporting means, on the other hand, speeds up the transfer of heat from the heated block to the inhalant and at the same time serves to puncture the inhalant container used, which is supplied in sealed form.

In order that the invention may be readily understood certain embodiments thereof will now be described by way of example with reference to the accompanying drawings in which:—

Fig. 1 is a longitudinal cross-sectional view through an ultrasonic inhaler according to the invention.

Fig. 2 is a diagrammatic view through a further embodiment, and

Fig. 3 is a sectional view taken along the line III—III of Fig. 2.

Fig. 1 shows the details of an ultrasonic inhaler with a replaceable inhalant container 1 and means 2 for conveying liquid to the resonator head 3. As is diagrammatically shown, the means 2 for conveying liquid abut on the resonator head plate 4. When the conveying means are actuated, inhalant emerges from the end of the liquid transporting means and is vaporised on the resonator head plate 4 of the resonator head 3. The actual conveying means 5 consists of the electric motor 6 with a gear 7 mounted thereon. The gear 7 acts on the power take-off 10 and causes both this and the hollow shaft connected thereto to rotate when the motor is in operation. A plunger in the form of a threaded spindle 13 is secured in the hollow shaft 11. At this bottom end, the threaded spindle 13 has a pin 14 which engages in a longitudinal slot 12 in the hollow shaft 11. The threaded spindle 13 is mounted between the fixed half 15 of the bearing and the bearing half 16 which is provided with an internal thread. The free end of the threaded spindle 13 has a pressure plate 8 and presses with the pressure plate 8 against the base surface of the inhalant container 1. The inhalant container 1 is accommodated in the conveying chamber 5 which is sealed off by the conveying chamber closure 18. This conveying chamber closure 18 is hinged to the housing 9 via an eccentric 17 and is held in the closed position by the locking means 19. When the conveying chamber closure 18 is closed, its eccentric movement causes the conveying chamber closure 18 to press against the bearing half which comprises an internal thread and which is also acted upon by the force of a spring 20. The eccentric movement causes the thread of the bearing half 16 to engage with the external thread 13 of the threaded spindle. At the very bottom of the hollow shaft 11 there is a compression spring 21 which acts on the base surface of the threaded spindle 13. An inspection window 24 for observation of the inhalant container 1 is provided in the conveying chamber 5. The diaphragm switch 22 is fixed inside the breathing mask.

The conveying chamber 5 is opened by unlocking the conveying chamber closure 18. This causes the bearing half 16 having an internal thread to move out of engagement and the threaded spindle 13 is movable in the hollow shaft 11 counter to the force of the compression spring 21. After the pressure plate 8 has been pressed downwards, the inhalant container 1 is inserted into the conveying chamber 5 and this chamber 5 is sealed off by means of the conveying chamber closure 18 by engaging the locking means 19. The bearing half 16 having an internal thread engages with the thread of the threaded spindle 13. The suction produced on breathing switches on the diaphragm switch 22. This supplies the motor 6 with current and the threaded spindle 13 with the pressure plate 8 is pressed against the base of the inhalant container 1. The liquid transporting means 2 convey the inhalant to the resonator head plate 4 of the resonator head 3 where it is atomised. The inspection window 24 makes it possible to see how much inhalant is present in the inhalant container.

A pin 23 formed in the base of the container 1 adjacent the pressure plate 8 serves to rupture the top wall of the container when it is empty and thus prevent any further, unauthorised, use of it.

Turning now to Figs. 2 and 3 there is shown diagrammatically an ultrasonic inhaler having means whereby the active substance can be heated before administration. As in the previous embodiment a conduit 2 conveys the liquid substance from the container 1 to the resonator plate 4 of the resonator head 3. In this case

however a heating block 25 is disposed around the conduit 2 and which is electrically heated to heat up to active substance as it passes to the resonator head so as to be at the optimum temperature for the treatment.

The block 25 is formed from two halves 26, 27 hingedly connected together by a hinge 28 to embrace the conduit 2. The half 26 is electrically resistance heated and conducts heat through conduit 2 to the active substance.

CLAIMS

1. An ultrasonic inhaler adapted for use with a replaceable inhalant container comprises a housing having a chamber adapted to receive a said container means being provided for conveying liquid expressed from the container to a resonator head, said housing further including means for forcibly collapsing said container said collapsing means comprising an electric motor adapted to rotate a hollow shaft having a longitudinal slot, a threaded plunger being coaxially disposed within said shaft and having a laterally projecting pin guidably received in said slot, said plunger threadedly cooperating with a thread formed in the housing such that on rotation of said shaft the plunger is forwardly urged, said plunger having at its forward end a pressure plate adapted to forcibly deform said container to express fluid therefrom to said head, said housing thread being formed in part of a hinged cover for said chamber.

2. An ultrasonic inhaler according to claim 1, in which a locking device is associated with the closure, and the said threaded part which forms a bearing half is operatively connected to a spring.

3. An ultrasonic inhaler according to claim 1 or 2 in which the plunger is operatively connected to a compression spring.

4. An ultrasonic inhaler according to any of the preceding claims, including a pressure sensitive diaphragm switch adapted to automatically operate the inhaler.

5. An ultrasonic inhaler according to any of the preceding claims in which at least one inwardly directed pin is disposed at the pressure end of the collapsible container.

6. An ultrasonic inhaler according to any of the preceding claims, in which an inspection window is provided in the housing.

7. An ultrasonic inhaler with a conduit for transporting liquid from a conveying means to a resonator head in which the conduit passes through an electrically heated block.

8. An ultrasonic inhaler according to claim 7 in which the block is formed of PTC material.

9. An ultrasonic inhaler according to claim 7 or 8 in which the block is formed in two parts which are hinged together and the conduit is located between these two parts.

10. An ultrasonic inhaler as claimed in claim 7, 8 or 9 in which the conduit is in the form of an elastically deformable tube which is heat resistant up to +90°C.

11. An ultrasonic inhaler as claimed in claim 7, 8 or 9 in which the conduit consists of a hollow needle.

12. An ultrasonic inhaler according to claim 11 in which the hollow needle serves to puncture the inhalant container which is supplied in sealed form.

13. An ultrasonic inhaler substantially as hereinbefore described with reference to the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1982. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained